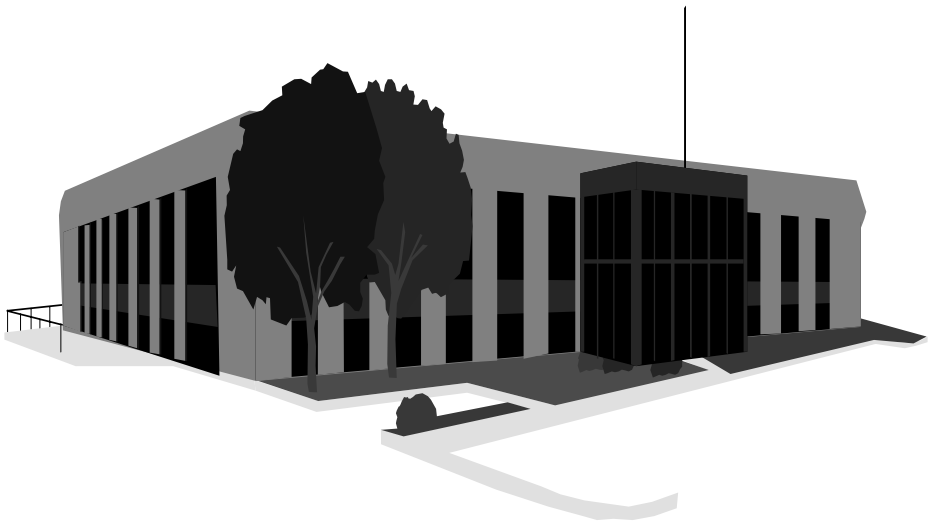
INDOOR AIR QUALITY ASSESSMENT

Paul Revere Elementary School
395 Revere Street
Revere, Massachusetts



Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
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Background/Introduction

At the request of a parent and Mayor Thomas Ambrosino, the Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality issues and health concerns at the Paul Revere Elementary School in Revere, MA.

On May 30, 2001 a visit was made to this school by Cory Holmes, Environmental Analyst for BEHA's Emergency Response/Indoor Air Quality (ER/IAQ) program to conduct an indoor air quality assessment. Mr. Holmes was accompanied by Suzan Donahue, BEHA Research Assistant, during the assessment.

The school is a two-story, brick building constructed in 1916 and was previously visited by the BEHA in December of 1997. The BEHA issued a report containing recommendations to improve indoor air quality (MDPH, 1998). On the afternoon of May 24th, BEHA received a call from a parent that the school had evacuated classroom 102 due to a number of individuals who experienced similar symptoms (e.g., headaches, nausea, dizziness).

According to the classroom teacher, a student started experiencing symptoms at approximately 10:00 am the morning of Monday May 21st and was promptly sent to the school nurse for evaluation. Over the next few hours several other students, a teacher's aid and parent volunteer all began experiencing similar symptoms. As a precautionary measure occupants of classroom 102 were temporarily relocated to the library. The classroom was reoccupied the following day without incident, however on Wednesday May 23rd several individuals complained of dizziness and the class was again relocated to the library. School Department officials contacted a consultant firm (ATC, 2001) to conduct air testing. ATC conducted real-time monitoring of carbon monoxide, carbon

dioxide, temperature, relative humidity, total volatile organic compounds (TVOCs) and respirable particulates. The ATC report stated that no abnormal readings were recorded. ATC did include a number of factors that existed in classroom 102 that could possibly contribute to poor indoor air quality but were not likely related to the specific symptomology reported (ATC, 2001). These conditions included 1) non-continuous outside air supply by the univent, 2) an unused sink in an adjacent room which can provide a source of sewer gas odors (i.e., dry drain trap), 3) the use of VOC containing markers 4) occasional food odors from a nearby restaurant, 5) deteriorated bird screens on rooftop exhaust vents, 6) accumulated dirt/dust in the exhaust shaft, 7) potential allergens from neighboring lawn, 8) periodic vehicle exhaust emissions from train traffic (ATC, 2001). At the time of the BEHA assessment the unit ventilator was activated and the classroom exhaust shaft/vent was cleaned of debris. ATC also took wipe samples from supply and exhaust ventilation components in order to evaluate fungal and bacterial growth. The school was awaiting the results of the biological sampling at the time of the BEHA assessment. Until ATC microbial testing results are available, school officials plan to continue to house classroom 102 occupants in the library.

Methods

Air tests for carbon dioxide, carbon monoxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551. Screening for total volatile organic compounds (TVOCs) was conducted using a Thermo Environmental Instruments Inc., Model 580 Series Photo Ionization Detector (PID). Outdoor TVOC levels were taken as comparison values to indoor levels. Measurements for hydrogen sulfide were

conducted with the BW Defender Multi Gas Detector. Measurements were taken in classroom 102 and surrounding areas.

Results

This school has a student population of approximately 500 and a staff of approximately 50. The tests were taken during normal operations at the school. Classroom 102 was vacant since occupants were temporarily relocated to the library. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels below 800 parts per million of air (ppm) in all areas surveyed indicating adequate air exchange. It is important to note however that the classroom was unoccupied at the time, which can greatly contribute to reduced carbon dioxide levels.

Fresh air in classrooms is supplied by a unit ventilator (univent) system (see Picture 1). Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building (see Picture 2) and return air through an air intake located at the base of each unit (see Figure 1). Fresh air and return air are mixed, filtered, heated and provided to classrooms through a fresh air diffuser located in the top of the unit. As previously reported by school occupants the univent was deactivated the week prior to the onset of symptoms. Therefore no mechanical means of fresh air was being provided to classroom 102 immediately prior to the relocation. Without dilution by supply ventilation, excess heat and environmental pollutants can build up and lead to indoor air complaints.

Importantly these units must remain "on" and allowed to operate while classrooms are occupied.

Mechanical exhaust ventilation is provided by wall-mounted intake grills, located at floor level, powered by rooftop motors. Exhaust vents have internal flues that are controlled by pull chains to adjust airflow. The exhaust vent for classroom 102 was functioning at the time of the assessment, however the exhaust grate was partially blocked (see Picture 3) by a hanging book holder.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last balancing of these systems was not available at the time of the assessment. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997, BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being

exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperature readings ranged from 72^{o} F to 73 ^{o} F, which were within the BEHA comfort range. The BEHA recommends that indoor air temperatures be maintained in a range of 70 ^{o} F to 78 ^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity was slightly below the BEHA recommended comfort range in all areas sampled. Relative humidity measurements ranged from 35 to 36 percent. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

Classroom 102 contained several water-damaged ceiling tiles along the exterior wall, which can indicate historic leaks from either the roof or plumbing system (see Picture 4). Water-damaged ceiling tiles and other porous building materials can provide a source of microbial growth and should be repaired/replaced after a water leak is discovered. The occupant reported no active leaks in the classroom.

Other Concerns

In response to occupant concerns/symptoms BEHA staff conducted testing for carbon monoxide, TVOCs and hydrogen sulfide. Carbon monoxide and hydrogen sulfide were non-detectable. Indoor TVOC levels were less than or equal to background levels, indicating no unusual source of volatile organic compounds (fuel oil vapors, solvents, etc.) contamination in the area on the day of the BEHA assessment. Building occupants interviewed reported no unusual activities (e.g., construction/renovation, application of cleaning materials, idling vehicles/deliveries) in or around classroom 102 that could be associated with acute symptoms reported. No obvious point sources of respiratory irritants (e.g., chemicals, office equipment, allergens) were noted in or adjacent to classroom 102 that can serve as potential irritants, with the exception of permanent markers. Materials such as permanent and dry erase markers may contain VOCs, (e.g., methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999), which can be irritating to the eyes, nose and throat. However, classroom occupants report that these materials have been used in the classroom since the beginning of the school year and are unlikely to have caused the acute symptoms reported.

Please note that regardless of environmental testing conducted on the day of the assessment the univent had been deactivated for several days prior to the onset of symptoms. The teacher also reported that windows were closed on the day of the incident due to inclement weather. The combination of lack of mechanical supply ventilation and closed windows can create uncomfortable conditions (e.g., stuffiness), exacerbate pre-existing conditions and contribute to poor indoor air quality complaints.

Conclusions/Recommendations

BEHA air-testing results indicate that no measurable levels of TVOCs, hydrogen sulfide or carbon dioxide were detected within classroom 102 and its surrounding areas at the time of the visit. In view of these conditions, the following recommendations are made.

1. To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy independent of classroom thermostat control.
2. Ensure univent fresh air diffuser, return vent and exhaust vent remain free of obstructions to facilitate airflow.
3. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is

recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

4. Facilitate airflow with the use of openable windows to control for comfort. Care should be taken to ensure windows are properly closed at the close of school hours.

5. Consider the use of low VOC-containing or water-based markers.

References

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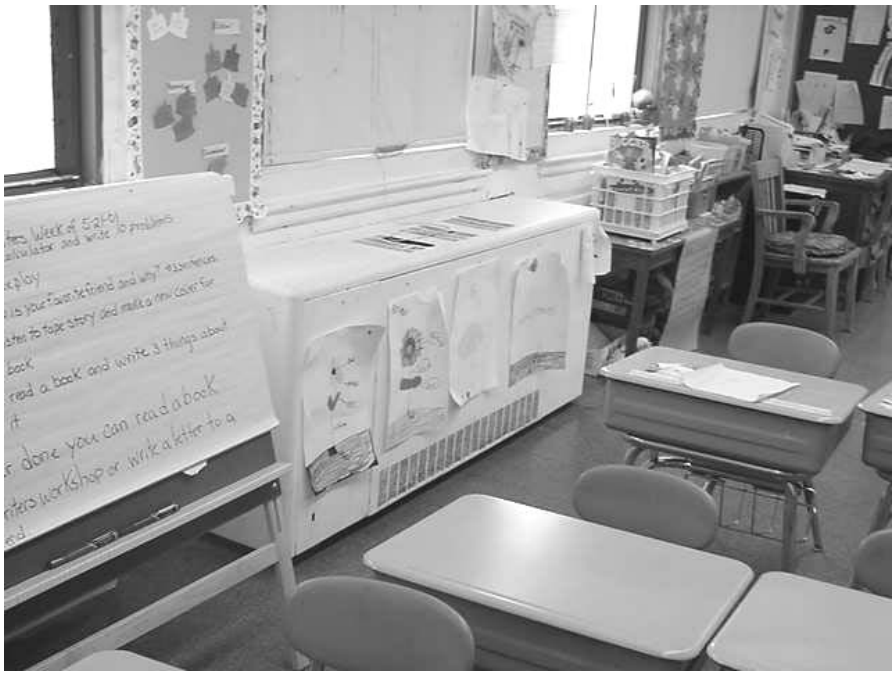
Picture 1



Classroom 102 Univent

Picture 2

Univent Outside Air Intake for Classroom 102

Picture 3

Classroom Exhaust Vent Note Vent is Obstructed

Picture 4

Water-Stained Ceiling Tiles

TABLE 1

Indoor Air Test Results – Paul Revere Elementary School, Revere, MA – May 30, 2001

Location	Carbon Dioxide *ppm	Carbon Monoxide *ppm	TVOCs	Hydrogen Sulfide	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation	
									Intake	Exhaust
Outside – East Side (Background)	484	0.1	0.2		64	28				
Outside – Building Front			0.0	0.0						
Room 102 – center room	753	0.0	0.0	0.0	73	35	0	Yes	Yes	Yes
Storage Closet	589	0.0	0.0	0.0	72	36	0	No	No	No
Back Stage Area	717	0.0	0.0	0.0	72	36	0	No	No	No
Back Stage – Sink				0.0						
Notes/Observations	6 water damaged ceiling tiles along exterior wall, opaque plexi-glass windowpanes, no apparent chemical/point sources, no vehicles in vicinity, room located at rear corner of building near playground, univent and exhaust on, permanent markers									

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%